

Article

Design and Test of a Low-Cost RGB Sensor for Online Measurement of Microalgae Concentration within a Photo-Bioreactor

Micaela Benavides ¹, Johan Mailier ¹, Anne-Lise Hantson ¹, Gerardo Muñoz ², Alejandro Vargas ², Jan Van Impe ³ and Alain Vande Wouwer ^{1,*}

¹ BioSys, University of Mons, Boulevard Dolez 31, 7000 Mons, Belgium;

E-Mails: micaela.benavides@umons.ac.be (M.B.); johan.mailier@fpms.ac.be (J.M.); anne-lise.hantson@umons.ac.be (A.-L.H.)

² Unidad Académica Juriquilla, Instituto de Ingeniería, Universidad Nacional Autónoma de México, Blvd. Juriquilla 3001, Querétaro 76230, Mexico; E-Mails: GMunozM@ii.unam.mx (G.M.); AVargasC@ii.unam.mx (A.V.)

³ Department of Chemical Engineering, Catholic University of Leuven, 3001 Leuven, Belgium; E-Mail: jan.vanimpe@cit.kuleuven.be

* Author to whom correspondence should be addressed; E-Mail: alain.vandewouwer@umons.ac.be; Tel.: +32-6537-4141; Fax: +32-6537-4136.

Academic Editor: Alexander Star

Received: 10 November 2014 / Accepted: 15 January 2015 / Published: 26 February 2015

Abstract: In this study, a low-cost RGB sensor is developed to measure online the microalgae concentration within a photo-bioreactor. Two commercially available devices, *i.e.*, a spectrophotometer for offline measurements and an immersed probe for online measurements, are used for calibration and comparison purposes. Furthermore, the potential of such a sensor for estimating other variables is illustrated with the design of an extended Luenberger observer.

Keywords: biomass concentration; microalgae; bioprocess; instrumentation; state estimation; monitoring; Luenberger observer; Arduino board
